1. Introduction

The U. S. Environmental Protection Agency (EPA) is developing a Cruise Ship Discharge Assessment Report in response to a petition the agency received in March 2000. The petition requested that EPA assess and where necessary control discharges from cruise ships. Comments received during public hearings, in 2000, resulted in the EPA agreeing to conduct a survey to assess the discharge plumes resulting from cruise ships, operating in ocean waters off the Florida coast and to compare the results to the Alaska dispersion models.

The EPA conducted a survey to track and quantify the plume dilution and dispersal, offshore Miami, Florida (Figure 1), and within the normal transit lanes for cruise ships operating out of Miami, on August 7-15, 2001. The survey was conducted aboard the U.S. Environmental Protection Agency's Ocean Survey Vessel *Peter W. Anderson* (OSV Anderson). The survey participants along with affiliation and survey responsibility are listed in Table 1. Mobilization for the survey was conducted at the U.S. Coast Guard Base in Miami, Florida on August 7, 8 and 9, 2001.

Table 1. Survey Party and Responsibilities.

Name	Affiliation	Survey Responsibility	Survey Dates
Dave Redford	EPA Headquarters	Chief Scientist	Aug 7-14, 2001
Ken Potts	EPA Headquarters	Work Assignment Manager	Aug 7-14, 2001
Wayne Trulli	Battelle	Battelle Lead Scientist	Aug 7-14, 2001
Bob Mandeville	Battelle	BOSS Operator	Aug 7-14, 2001
Stacy Abramson	Battelle	Sampling Technician	Aug 7-14, 2001
Tim Kaufman	Battelle	Winch operator	Aug 7-14, 2001
Brandy Curtis	Battelle	Sampling technician	Aug 7-14, 2001
Kenwyn George	Alaska DEC	Observer	Aug 10-13, 2001
Bob Howard	EPA Region IV	Observer	Aug 10-13, 2001
Don Kim	AMSEC	Observer	Aug 10-13, 2001
Stan Demo	ICCL	Observer	Aug 10-13, 2001

EPA worked with the International Council of Cruise Lines to identify cruise ships, their location, transit routes and sailing schedules, and to coordinate with the needs of the survey. EPA worked closely with Royal Caribbean Cruise Lines and Carnival Cruise Lines representatives and ship personnel to understand the complexities of identifying holding tanks, and to coordinate the addition of dye to tanks, and the discharge of dye and drogues. The bridge officers from the OSV Anderson and cruise ships also met to discuss protocols of handling the ships while in close proximity of each other.

The dye plumes of four cruise ships were monitored: the *Majesty of the Seas*, the *Explorer of the Seas*, the *Paradise*, and the *Fascination*. The *Majesty of the Seas* and the *Explorer of the Seas* from Royal Caribbean Cruise Lines were monitored on August 10 and 11, respectively; and the

Paradise and *Fascination* from Carnival Cruise Lines were monitored on August 12 and 13, respectively. The tracklines followed during monitoring for each ship are shown in Figure 1.

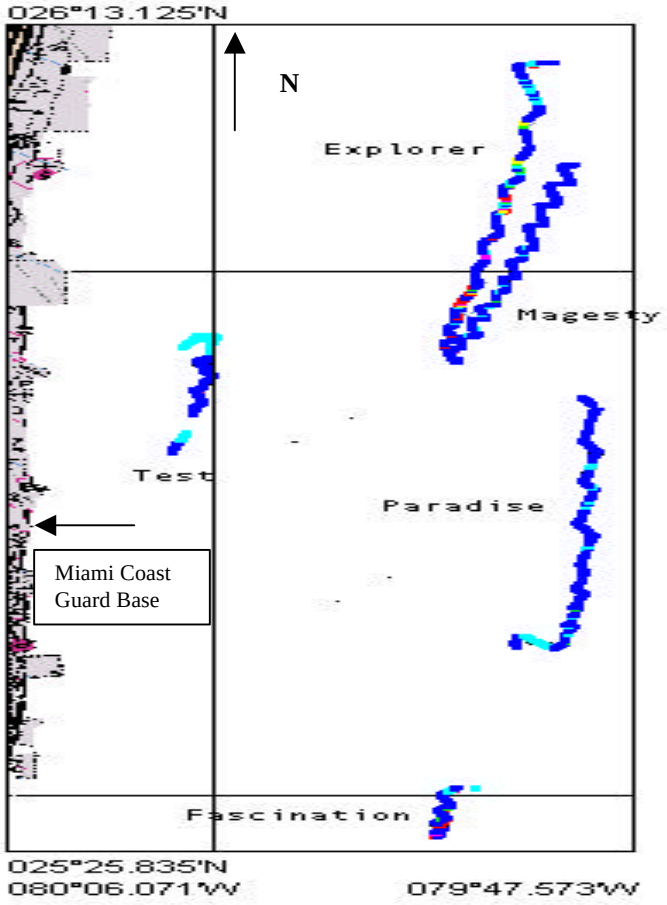

Figure 1. Miami, FL, Offshore Study Area Showing Tracks Through the Plumes of Each of Four Cruise Ships Monitored.

This survey report describes the daily activities of *August 2001 Cruise Ship Plume Tracking Survey*, and provides a synopsis of the observations from the survey. It also provides data that can be used to assess dispersion of cruise ship wastewater discharges, while in transit. A description of the survey methods is provided in Section 2. Survey results are presented in Section 3. Findings and conclusions are discussed in Section 4.

This study finds that dilution of discharges behind cruise ships moving at between 9.1 and 17.4 knots are diluted by a factor of between 200,000:1 and 640,000:1. Measured dilutions are significantly higher than the 40,000:1 initial dilution predicted by a model developed by Colonell et al (2000), suggesting that secondary dilution is an important factor.